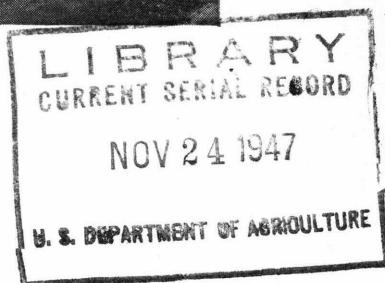
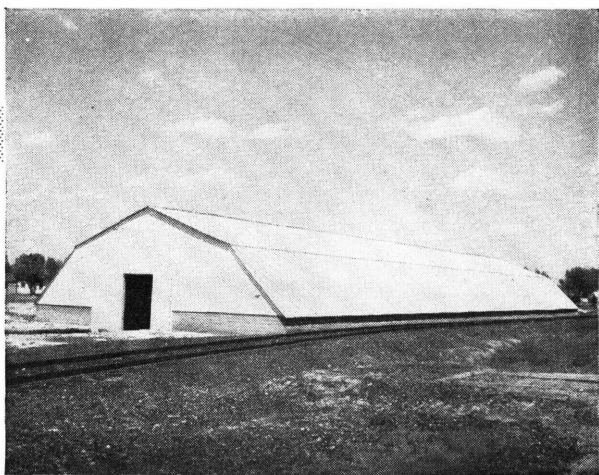


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POTATO STORAGE



U. S. DEPARTMENT OF AGRICULTURE
FARMERS' BULLETIN No. 1986

FOR centuries pits, mounds, and earth-covered cellars have been used for storing potatoes. When properly constructed and managed the earth-covered cellar is economical, gives fair protection from water and frost, and in cool climates keeps potatoes in excellent condition.

With a better understanding of warehouse construction and market requirements, more convenient, dependable, and permanent potato storages are now being built. These new storages use insulated and weathertight roofing and wall siding, have provision for handling potatoes conveniently and with a minimum of bruising, and are easy to manage. Careful handling and efficient management are still the main considerations in keeping potatoes in any type of storage.

The illustration on the cover is of a 50,000-bushel storage in Colorado, 50 by 200 feet, equipped with a forced-air circulation and ventilation system, and having dampers in the far end.

The bulletin presents information and plans for storing potatoes in the parts of the United States where climatic conditions permit good storage without refrigeration. It supersedes Farmers' Bulletin 847, Potato Storage and Storage Houses.

Potato Storage

By ALFRED D. EDGAR, *agricultural engineer, Division of Farm Buildings and Rural Housing, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*

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NEED FOR ADEQUATE STORAGE

THE grower often has no measure for estimating losses in potato weight and quality caused by poor storage. Sound and disease-free potatoes may be kept in almost any kind of storage for 2 or 3 months with little noticeable loss or damage, but after that the value of carefully planned storage increases markedly.

Good storage not only serves to hold this perishable crop in a salable condition but also to insure a more uniform market supply throughout the season. It provides the proper conditions for preserving the natural quality of the potato for table purposes or its vigor for seed. More adequate farm storage facilities and improved warehouses are needed in many areas.

Growers often prefer to store potatoes on the farm because they can use their own judgment and suit their convenience as to methods of handling, storing, and marketing. Roads and transportation facilities now are usually such that potatoes can be hauled from most farms throughout the storage season to meet market demands, and often truckers buy direct from the farm, relieving the grower of the hauling.

Cooperative and commercial warehouses and grading plants provide an alternative method for storing and shipping small lots of potatoes received from many farms. These plants may be centrally located and under trained management. They make possible carlot shipments at any time and have been a distinct advantage to the small grower. One disadvantage of the warehouse storage

system, however, is that it requires more time, labor, and hauling during the harvest season, particularly when there is congestion and delay at the central warehouses.

A potato in storage lives and uses oxygen, giving off moisture, heat, and carbon dioxide.¹ These processes, which are more rapid at high than at low temperatures, reduce the weight of potatoes available for sale. The principal storage requirements for sound potatoes are control of temperature and humidity within narrow ranges during the storage period. In addition, the storage should protect the potatoes from sunlight, artificial light, and mechanical injury. Storages should be so designed that moisture will not condense on the ceiling and harm the building or the potatoes. Condensation on concrete or vaporproofed walls causes little damage to buildings or potatoes.

The keeping quality of stored potatoes is affected by injuries or diseases that occur before storage begins. The number and roughness of handling operations directly affect the number of bruises and cuts, though mature potatoes are injured less than immature ones, and warm potatoes less than cold ones. Typical percentages of injury to potatoes handled and stored according to common methods and to those picked and stored field run in picking boxes are shown in figure 1.

Some potato varieties have fairly tough skins and would be damaged less than those shown in figure 1, but varieties having a tendency to form knobs are especially subject to bruising.

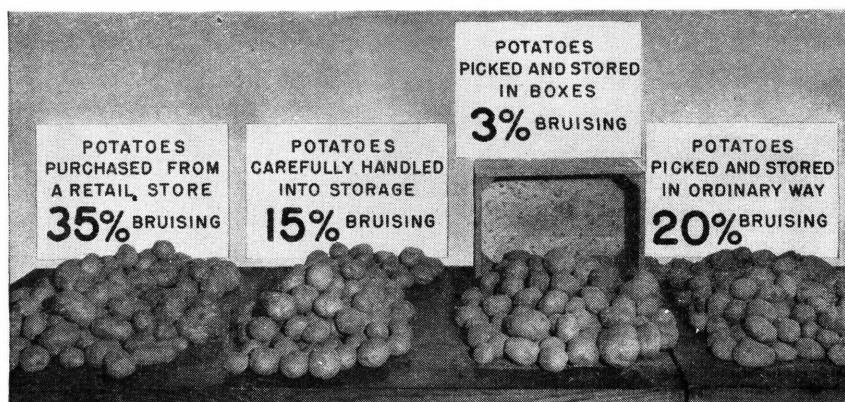


Figure 1. — Results of various handling methods on potato injury: 3 percent injury, picked and stored field run in picking box — one handling; 15 percent, graded as picked into crates and stored in bulk — two handlings; 20 percent, picked into baskets, dumped into crates, graded, and stored in bulk — four handlings; 35 percent, handled as in the 20-percent lot, but, in addition, graded from storage, shipped to market, and delivered to retail store — six to eight handlings.

¹ Under ordinary conditions 100 pounds of potatoes will give off about a pound of water by evaporation during the first month of storage. During the third month, if the potatoes have been cooled to 40° F., they will give off about one-fifth as much water. Under similar conditions 240 pounds of potatoes will throw off about as much heat the first month as the burning of 1 pound of coal in a stove and, during the third month, about one-fourth as much. Thus potatoes give off the most heat in fall, when it must be disposed of, and least in winter, when it is needed.

Allowing late potatoes to lie on the ground, following digging, for 15 to 30 minutes tends to toughen the skin and thus to reduce injury from subsequent handling. While this field curing may be good practice for the late crop when field temperatures are moderate and the humidity high, it may not be desirable for the intermediate or early crop when there are warm dry winds. Under warm, dry, field conditions potatoes should be picked as soon after digging as possible, since browning develops and minor potato injuries do not heal but become more serious during storage.

Damage from infection and frost, which may not be apparent when the potatoes are placed in the house, will also often result in serious loss during storage or in transit.

STORAGE REQUIREMENTS

In considering temperature and humidity requirements the storage period should be divided into three parts: (1) The initial wound-healing period, (2) the holding period, and (3) the warming period (for winter marketing).

WOUND-HEALING PERIOD

Stored potatoes are subject to some types of disease infection from adjoining potatoes, especially through freshly bruised or injured skin. Holding potatoes for 2 weeks at about 60° F. and at 90 percent relative humidity, however, allows the injured areas to heal over by formation of a corky layer that reduces the spread of infection.²

HOLDING PERIOD

For the best-quality table stock for marketing within 3 or 4 months after harvest, potatoes should be held at a minimum storage temperature of 50° F. But those to be held longer, whether for table stock or for seed, should be cooled to 40° during the first 3 or 4 months, to avoid later sprouting and excessive shrinkage. A temperature of approximately 40° F. has been found to be a most desirable compromise for long-period storage, because the shrinkage is small, the cooking quality fair, the sprouting retarded, and the germination satisfactory when the potato is planted in warm soil.

Prolonged storage below 40° F. makes table stock sweet and soggy and seed potatoes slow to sprout. Freezing, which occurs at about 29° for potatoes, may cause large losses, because every frosted potato in bulk storage may discolor or rot many of those adjoining.

Shrinkage loss increases with the length of the storage period, but potatoes may be kept in good condition for at least 8 or 9 months at a storage temperature of 40° F. and a relative humidity of 90 percent without undue sprouting or shrinkage. Mature po-

² Recent evidence indicates that under certain conditions net necrosis discoloration is greatly reduced if the temperature is lowered to 36° to 40° F. immediately after harvest and the potatoes are held at this temperature for at least 60 days. Special care should be taken in digging and handling potatoes to be stored in this way, since cuts and bruises do not heal rapidly at these temperatures.

tatoes are less subject to injury and will keep better than those not fully mature, although they may start sprouting 1 to 8 weeks earlier.³ A late blight epidemic has become a serious problem in potato storage, but losses will be minimized by culling out all visibly infected tubers and by maintaining the conditions outlined.

It is usually difficult to hold potatoes until late spring unless automatic ventilation and circulation are used to keep the storage temperature down while the weather is getting warmer.

WARMING PERIOD

During the last 2 weeks before marketing, potato temperatures should be raised to about 50° F. to reduce injury during grading, if this can be done without increasing the temperature of adjoining bins intended for continued storage at 40°.

FACTORS IN CHOICE OF STORAGE PLAN

The choice of a potato storage plan depends upon: (1) Storage period and market demands, (2) size of storage and the part filled during the coldest month, (3) air and ground temperatures during storage, (4) potato handling methods, (5) building site and drainage, and (6) availability of building materials.

STORAGE PERIOD AND MARKET DEMANDS

For short-period storage—3 or 4 months—potatoes may be kept under a wide range of conditions, and no special provision need be made for storage regulation. For longer storage a narrow range of conditions and special provisions for regulation are necessary, and the storage should be so designed that it is easily maintained. A protected space for grading is desirable if the crop is to be marketed in winter. If snow is likely to prevent road or highway travel during the marketing period, the trackside type storage (fig. 2) is most suitable for large growers. Where year-round hauling is possible the bulk of the crop may be kept on the farm and marketed direct to truck haulers, or it may be hauled to central grading plants for shipping.

QUANTITY STORED

Small quantities of potatoes, ordinarily stored for relatively short periods, may be kept in almost any available space—in pits or dwellings or barn basements, for instance. If the quantity is large enough to justify the cost, a special storage on the farm may be more satisfactory. Small special-storage buildings are relatively high in cost per bushel of capacity and are more difficult to insulate for severe winter weather than larger ones. The material requirements per bushel, for example, are less than half as high for a 5,000-bushel house as for a 500-bushel house. Increasing storage capacity beyond 5,000 bushels, however, does not substantially reduce the requirements.

³ WRIGHT, R. C., and PEACOCK, W. M. INFLUENCE OF STORAGE TEMPERATURE ON THE REST PERIOD AND DORMANCY OF POTATOES. U. S. Dept. Agr. Tech. Bul. 424, 22 pp. May 1934.

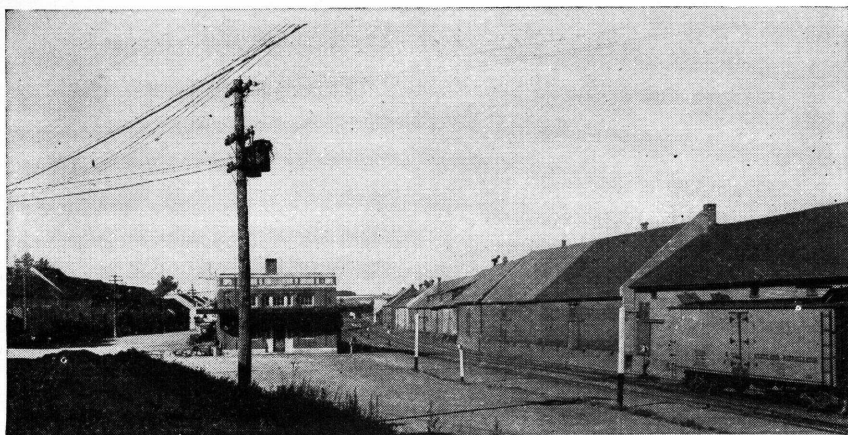


Figure 2. — Trackside storages in Maine are usually placed end to end on sidings. Capacities are 24,000 bushels and up per shipping door.

AIR AND GROUND TEMPERATURES DURING STORAGE PERIOD

The temperature of the earth 10 feet below the surface is about the same as the average annual temperature of the locality (fig. 3). Unlike the air temperature the ground temperature remains quite steady throughout the year, reaching in September and October a high of 3° to 5° above and in March and April a low of 3° to 5° below the average annual air temperature. Because of the temperature-regulating effect of the earth, potato storages in areas where the average annual air temperature is below 55° are ordinarily built at least partly underground. Average annual temperatures of 40° or lower occur only in the most northern States

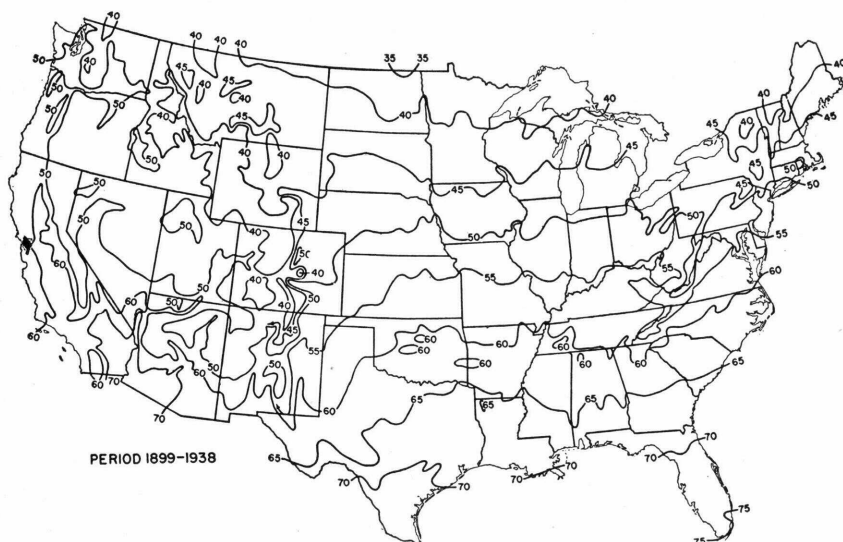


Figure 3. — Average annual air temperature ($^{\circ}$ F.).

and in the western mountain regions. Here the ground tends to keep potatoes in deep cellar storages at the proper long-period storage temperature.

Where the average annual temperature is above 40° F., the ground tends to keep a storage too warm. The outside air, however, may be helpful in lowering the storage temperature to a desired point, or it may have a tendency toward making the storage too cold. The proportion of the storage above ground level and the extent of wall and ceiling insulation regulate the effect of the outside air upon the storage temperature. Average January air temperatures are shown in figure 4. It is seldom possible to get storage temperatures of 40° or below without refrigeration unless

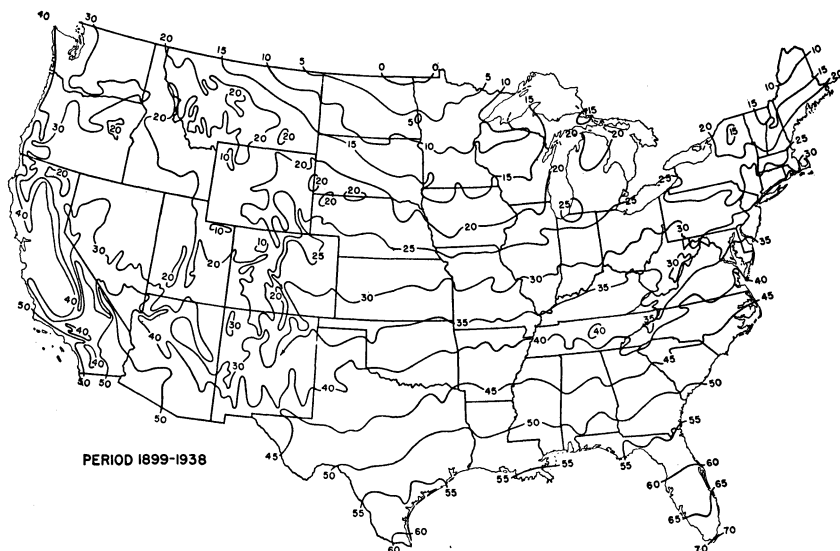


Figure 4. — Average January air temperatures. Weather records over a period of years where January averages are 5°, 20°, and 30° F. indicate extreme minimums of about —45°, —30°, and —20°, respectively, and the coldest monthly average of about —10°, 10° and 20°, respectively.

the average January temperature is 30° or lower. If the storage is built where the average annual temperature is 55° or below and the average January temperature is 30° or lower, desirable storage temperatures can be obtained with a minimum of ventilation or stove heat by adjusting the depth of the storage in the ground.

POTATO HANDLING METHODS

Storage design should take into account potato handling methods, which vary with the size of the storage and the customs of the production area. Where the storage is designed to permit the truck loaded with potatoes from the field to stand beside or above the bin, the type of field and truck handling container makes little difference; but where the potatoes are moved a considerable distance between truck and bin, the type of container becomes important.

Storages shown in figures 2 and 5 are designed primarily for barrel handling. Storages of the type shown in figure 32 (p. 31) may be used with potatoes picked and transported in bags, crates, barrels, or other containers. For bulk handling of potatoes into basements of dwellings and out-of-the-way spaces a conveyor is a convenience. Conveyor handling, however, often causes large losses from mechanical injury.

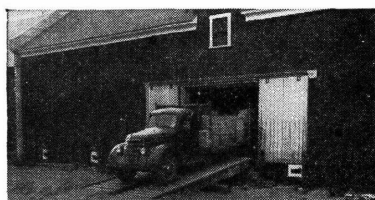
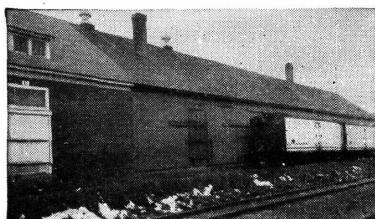
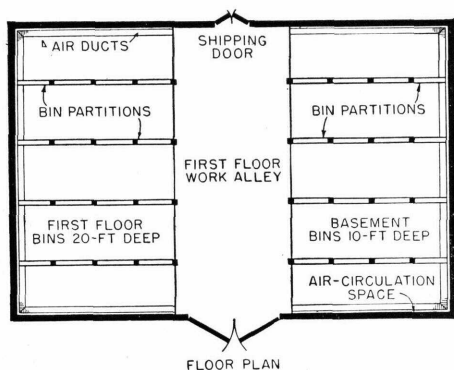


Figure 5. — Maine trackside storage. Many of these newer houses are so arranged that trucks can be driven into the work alley for unloading. To fill upper bins, barrels are hoisted to elevated platforms.

Recent builders of farm storages have frequently placed a truck garage at the lower entrance. The arrangement shown in figure 6 permits a truck to be loaded under cover with greater comfort and with less disturbance to the storage during stormy weather. Furthermore, storage walls can be of concrete and banked with earth on all sides.

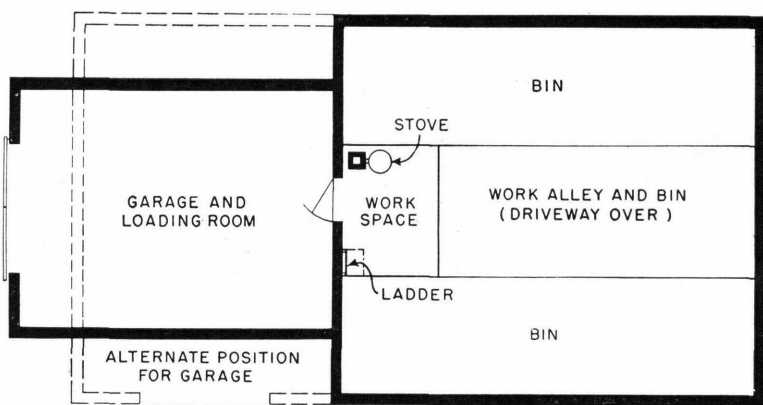
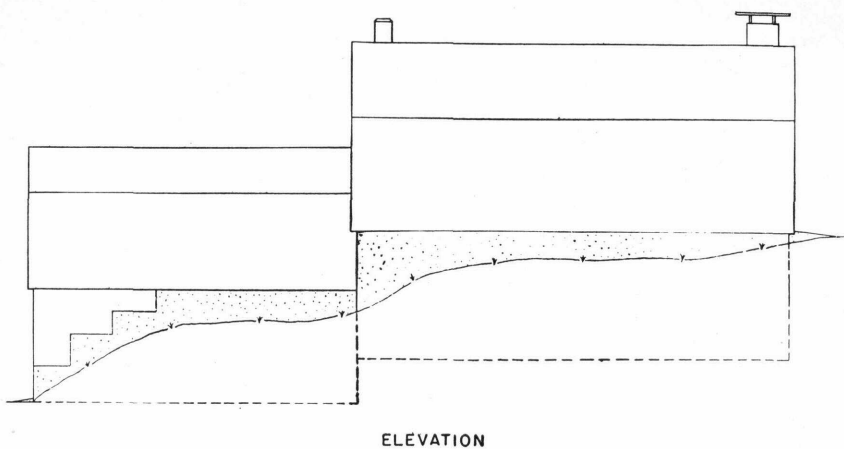
BUILDING SITE AND DRAINAGE

A commercial storage should be on a well-drained site, either on a railroad siding or an all-weather highway. For a farm storage it is important to have a well-drained site, easy access to an all-weather highway, and a location near the farmstead for convenient observations and odd-time grading operations. It may be more practical to build the storage (fig. 7) on a level site near the farmstead than on an ideal hillside site (fig. 8)⁴ that is remote.

AVAILABILITY OF BUILDING MATERIALS

The choice of a storage type should take into consideration the availability of building materials. Where good sand and gravel are available locally, concrete construction with earth banking

⁴ Working drawings for exchange plans shown in this bulletin are available from the extension services of many of the State agricultural colleges. If your State does not have them, you can get information on other sources of supply by writing to the U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, Division of Farm Buildings and Rural Housing, Beltsville, Md.



LOWER FLOOR PLAN

Figure 6. — Garage and loading room built at lower end of Maine-type farm storage to facilitate truck loading.

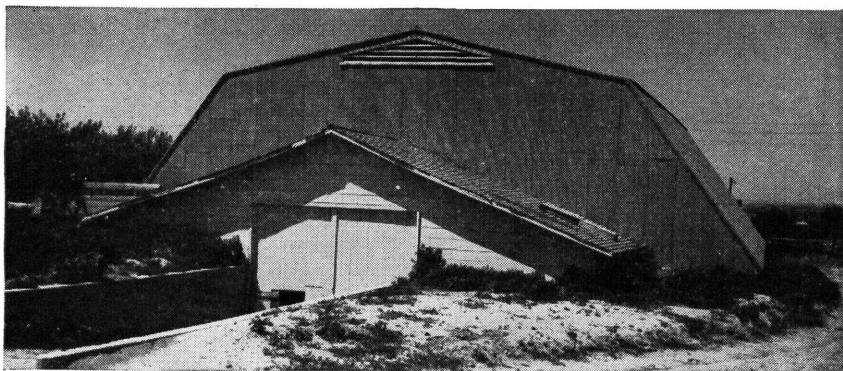


Figure 7. — Deep-bin farm storage with a lower drive — upper drive at opposite end — built on a level site.

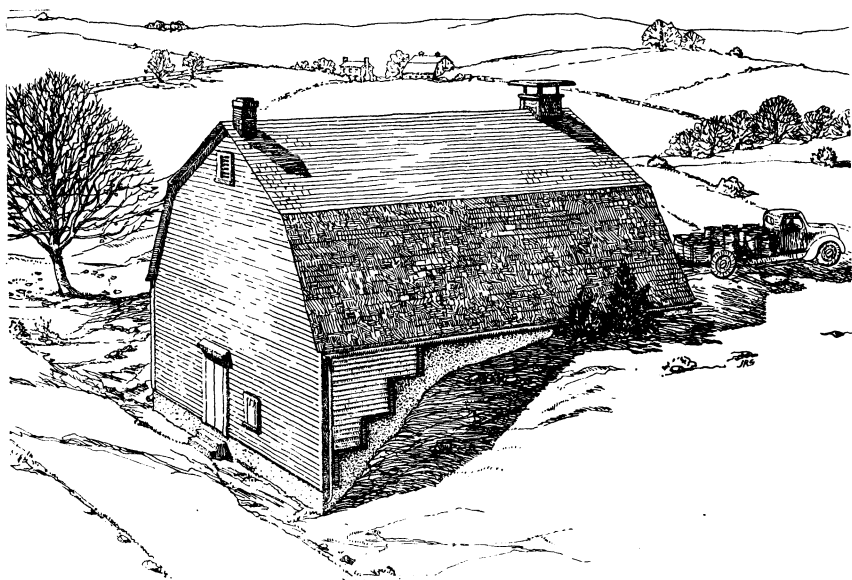


Figure 8. — Maine-type 14,000-bushel farm storage. Exchange Plan No. 5643.

may be more economical than insulated frame construction; thus the Maine plan may be more desirable than the Michigan plan (fig. 9, B). But where concrete work is more expensive than insulated frame construction, the choice of type may be reversed. Where clay products are locally produced, wall air-circulation spaces of clay tile may be more desirable than spaces enclosed with lumber.

TYPES OF STORAGES

PIT OR MOUND

The simplest method of potato storage is pitting or mounding. Success depends upon having a well-drained site and adjusting the pit depth and potato covering to suit the weather and the period of storage. Low cost of construction is the chief advantage of pitting, but losses due to unfavorable weather often make this type of storage the most expensive. Where the average annual temperature is above 55° F. (fig. 3), potatoes cannot be satisfactorily stored in pits for more than 3 or 4 months.

Common pitting practice is to make a shallow pit 6 to 12 feet wide, 1 to 3 feet deep, and as long as may be required. Several short pits are often better than one long one, as they reduce the spread of disease and, without endangering other pits, may be emptied one at a time during favorable winter weather. Potatoes are piled into the pit in wedge or pyramid shape and are then covered with successive layers of straw or earth, as required by weather conditions (fig. 10). In areas where the average January temperature is about 30° F. (fig. 4), the pit cover may be made up of a foot of straw and a total of about 6 inches of earth, which

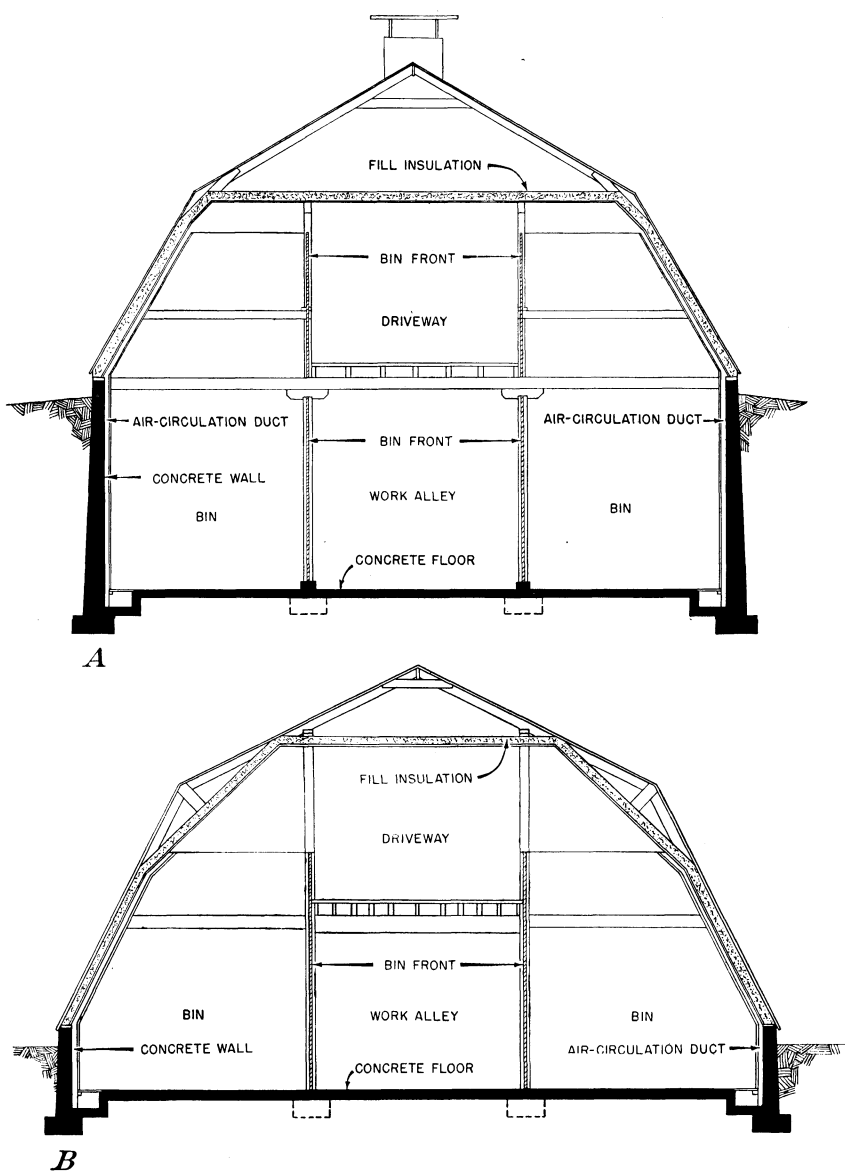


Figure 9. — Cross sections of (A) Maine storage, Exchange Plan No. 5643, and (B) Michigan, No. 5619, showing difference in relative amounts of concrete and frame construction.

should be sufficient to shed water. For colder locations, additional layers of straw and earth will be required.

Begin the storage season by covering the potatoes with just enough straw to protect them from sunlight, evaporation, and early frosts. Then, as the weather becomes severe, add more straw and earth for protection against freezing and storm moisture. Success or failure in pitting depends upon the grower's ability to predict the weather with some accuracy. If insulation

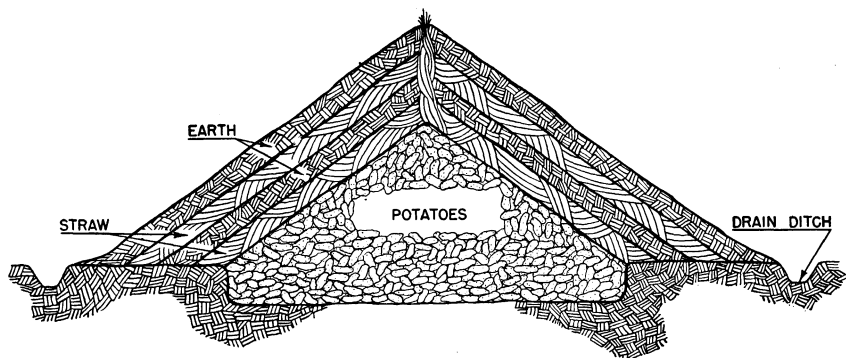


Figure 10. — Cross section of a potato pit.

in the form of straw and earth is added too rapidly or if there is an unusual depth of snow cover, the potato temperature will remain high and early sprouting will occur; but if the earth and straw covering is added too slowly or there is less than average snow cover, freezing may cause large losses.

BASEMENT

Potatoes are often stored in basements of various buildings that are not especially fitted for the purpose. Lack of provision for convenient handling in such basements often results in excessive mechanical injury.

Residence and store basements or those of large heated buildings are likely to be too warm and dry for long-period storage, but may be satisfactory for a shorter time. If the quantity of potatoes to be stored is more than 8 to 10 bushels it may be practical to partition off part of the home basement with suitable insulating material (fig. 11).

Relatively small quantities of potatoes stored in basements, where the humidity is likely to be low, will be firmer if kept in paper-lined baskets or boxes (fig. 12) than if stored in open bins, sacks, or crates. A desirable material for box liners is asphalt-

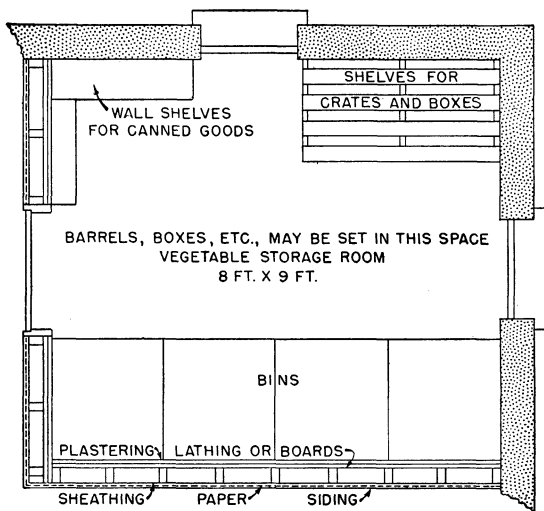


Figure 11. — Floor plan of a storage room in a corner of a basement. The arrangement of the shelving and bins may be changed to suit conditions. While the wall construction may be varied, it must be tight.



Figure 12. — Type of box lining that reduces shrinkage of potatoes stored where the air is dry.

saturated crinkled kraft building paper, which will stand refolding and may be used for 2 years or more.

Bank-barn basements may be satisfactorily remodeled into potato storages if attention is given to insulation, air circulation, and ventilation, as indicated in figure 13. The ceiling of this storage, under the haymow, was insulated with sawdust, supported by vapor-resistant sheathing, and air-circulation spaces were added next to the walls on the four sides of the building. The storage space was divided into bins and a work space. Although

an intake fan is better adapted to thermostatic regulation (see p. 33), an outtake ventilation fan was used to advantage.

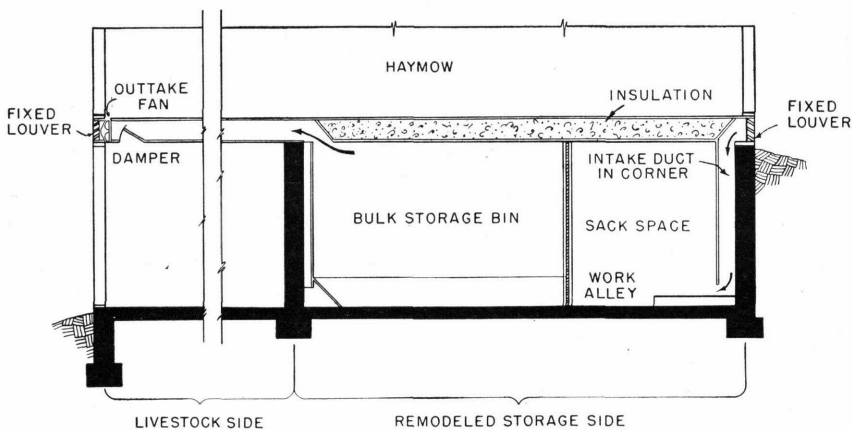


Figure 13. — Section of a Lake City, Mich., barn with a built-in potato storage room.

ABOVE-GROUND STRUCTURES

The all-above-ground storage (fig. 14) is little influenced by the regulating effect of ground temperature. It is best adapted to areas where the average annual temperature is above 55° F. (fig. 3, p. 5). Large houses of this type, however, if well insulated and heated, are fairly satisfactory in Michigan and Maine and

are sometimes built where a high water table limits basement depth (fig. 15).

Above - ground houses depend on stove heat to prevent chilling or freezing of potatoes in cold weather. They are subject to greater temperature fluctuations than houses that are all or partly below ground level. To regulate storage conditions in the

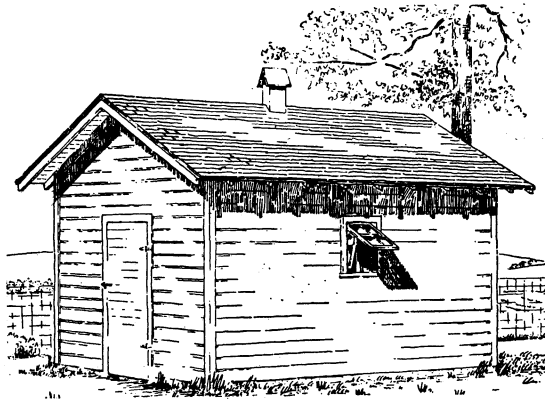


Figure 14. — Above-ground 600-bushel potato house. Exchange Plan No. 5492.

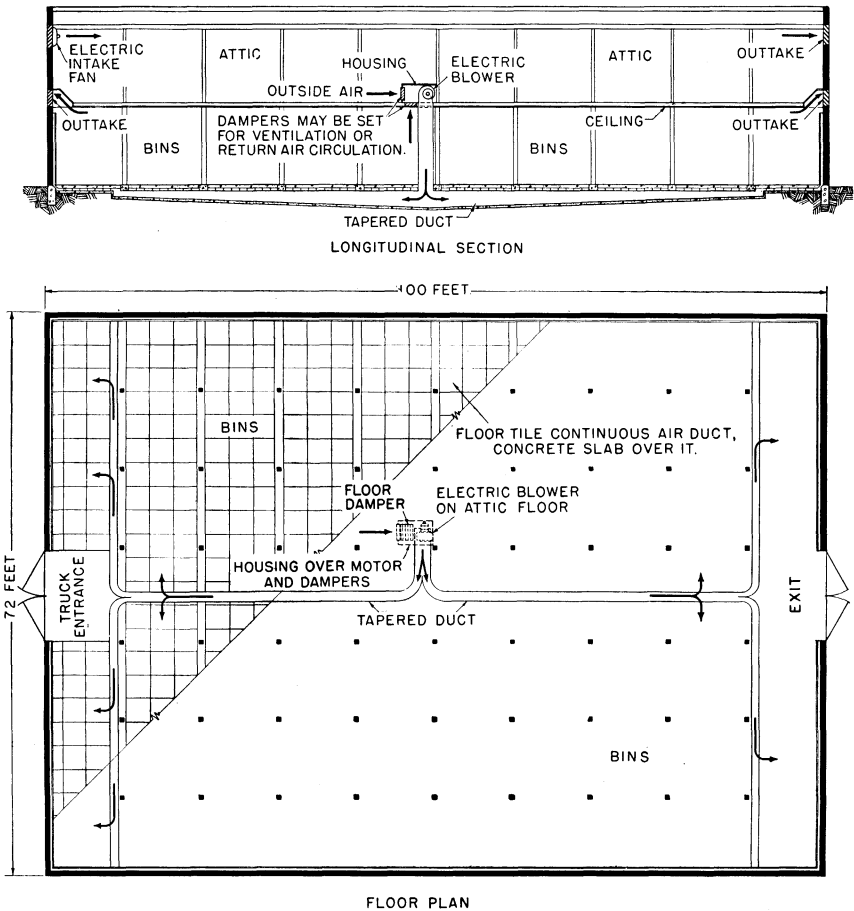
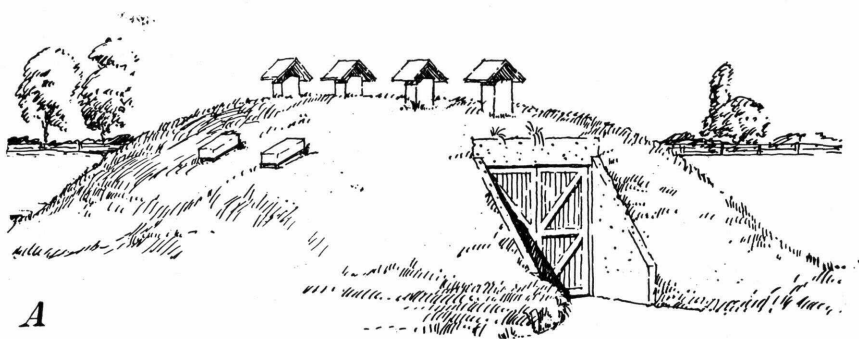


Figure 15. — Above-ground 25,000-bushel potato storage with forced air circulation. Exchange Plan No. 5644.

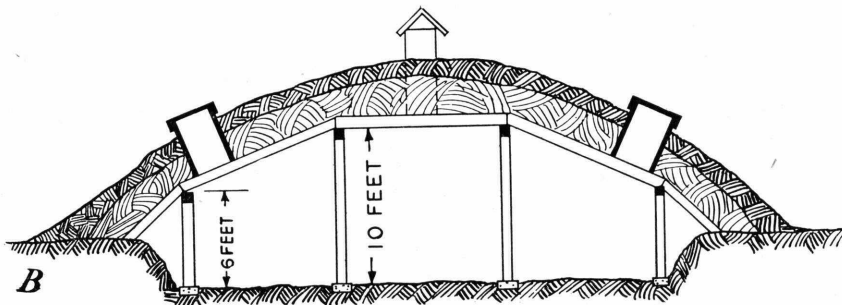
warmer parts of the country (average annual temperature above 55° F.), thermostatic control of forced circulation and ventilation is desirable for lowering potato temperatures (p. 33).



Figure 16. — Experiment station storage at Aberdeen, Idaho. Its low earth ledge is the undisturbed ground level; supports for roof at sides.



A



B

Figure 17. — A, 6,500-bushel earth-covered storage, built on a level site; B, sectional view. Exchange Plan No. 5504.

SINGLE-DRIVE EARTH-COVERED STORAGE

Earth-covered storage houses of various kinds are probably more widely used for potato storage than any other type of building. On level sites the excavation for an earth-covered storage

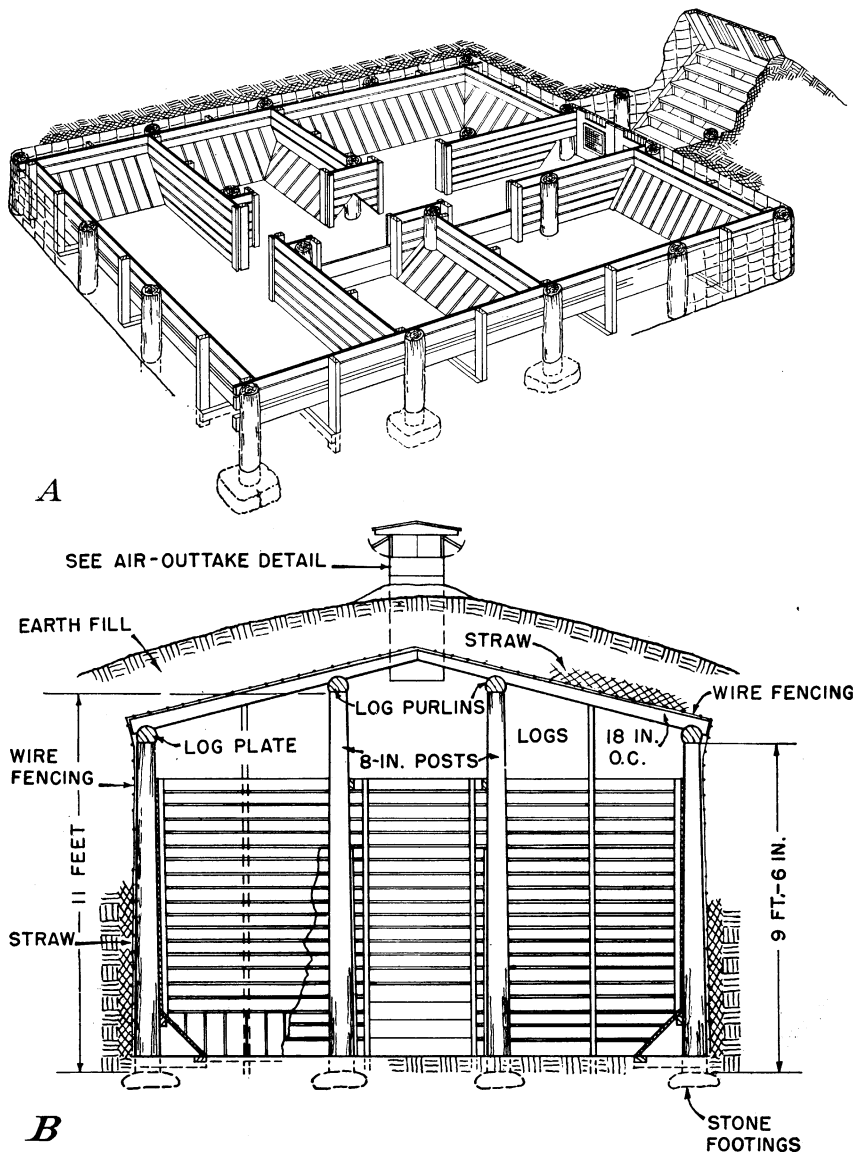


Figure 18. — Cutaway perspective (A), and section (B), of a 1,200-bushel earth-covered storage adapted to a bank site. Exchange Plan No. 5491.

may be only 2 or 3 feet deep (figs. 16 and 17), with just enough earth to bank sides and roof. On bank or ridge sites the excavation may be 8 or 10 feet deep and the finished roof nearly level with the hill into which the structure projects (fig. 18).

As the earth banking continues up over the roof, these storages are more affected by earth temperature than other types and, consequently, are often described as being cool in summer and warm in winter, although they are not necessarily at the right temperatures for good potato storage in either summer or winter. The underground part of a storage tends to keep the potatoes at an average annual temperature; that is, to retard cooling in fall, maintain above-freezing temperature in midwinter, and retard the spring warm up.

Earth-covered storages are particularly adapted to high-altitude areas where the nights are cold, the days usually mild and sunny, and the rainfall low. An earth cover has considerable temperature-regulating value and also fair insulating value when it is dry. These storages are most economical when constructed entirely of materials at hand, using poles for framing, brush and straw over the poles, and earth taken from the excavation for cover and banking.⁵ A layer of earth 6 inches deep is recommended for average January temperatures of 30° F., 12 inches for 20°, 18 inches for 10°, and 24 inches for 0°. The cover should be kept at a fairly uniform slope of about 1 foot rise in 4 feet of horizontal distance all the way to the ridge. It will require frequent repairs, owing to erosion and to pockets caused by uneven settling of the supporting straw.

Earth-covered storages in areas having less than 15 inches of annual rainfall are ordinarily protected from storm water by the earth covering, although unusually heavy rains or sudden thaws may cause some leakage, even through a well-sloped roof. Where the rainfall is more than 15 inches the average earth cover is hardly sufficient as a storm-water protection. A practical method for making the storages usable in these areas is to cover the earth with a roof (fig. 19) or simply to remove the earth and replace it with roofing.

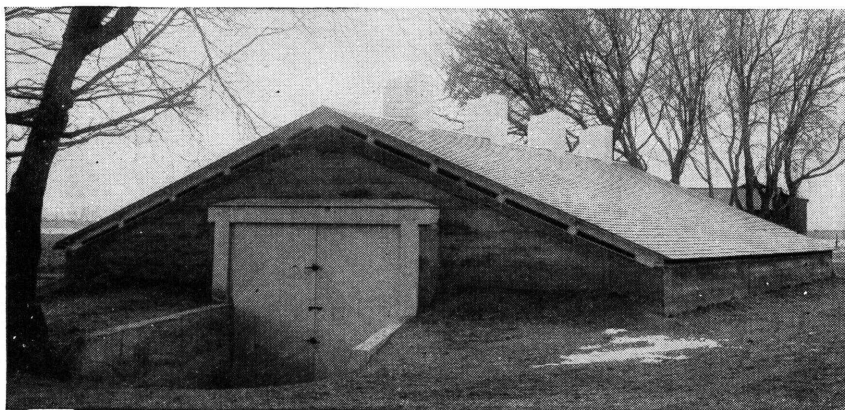


Figure 19. — Earth-covered storage with shingle roof built over the original earth cover.

⁵ Straw used to support earth has no practical insulation value after the second or third year, as it rots and is compressed by the earth cover. It is valuable, however, in forming channels to permit the circulation of air around the rafters, which helps to preserve these members.

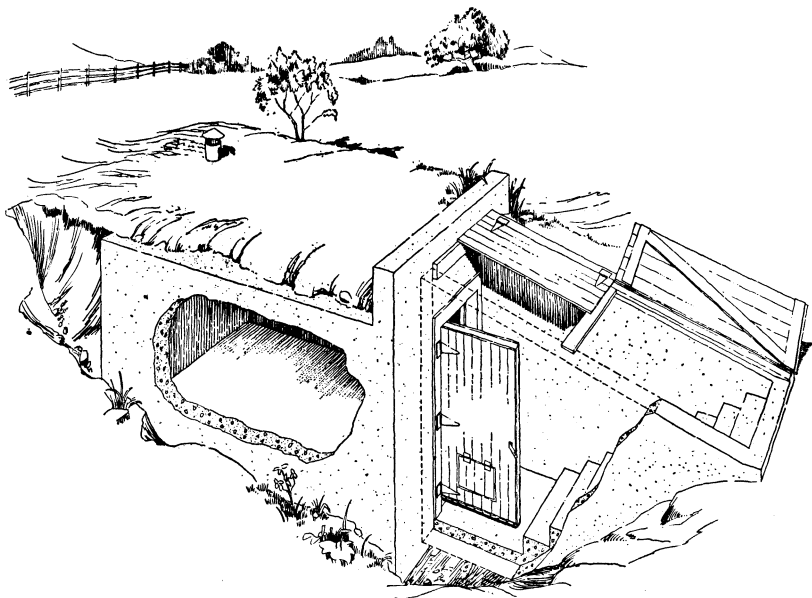


Figure 20. — A 300-bushel earth-covered concrete potato storage. Exchange Plan No. 5176.

A number of storages now in use are built with a reinforced concrete slab to support the earth cover (fig. 20). This type of construction avoids failure due to termite damage, but with high rainfall the earth cover will remain wet or frozen throughout the storage season. In this condition its insulation value is so low that stove heat or snow cover may be needed to regulate the storage temperature. If the soil is not saturated with moisture, its dry insulation value may be sufficient protection.

In midwinter the coldest place in a storage having a reinforced concrete roof is that part of the ceiling where the earth cover is thinnest. Here moisture will condense and drip because of mounting humidity if the storage is closed for a few days. Sufficient ventilation, combined with heating if needed, could be employed to prevent condensation, but this requires either automatic ventilation or considerable operator attention that would not be required if only temperature were being regulated. To enable a storage operator to get satisfactory storage conditions by regulating the temperature only, ceiling drip pans (something like the pans used under coils in a cold-storage plant) may be used. Moisture then is allowed to condense and drip from the ceiling, but is caught and drained to suitable containers or sumps. The pans must be staggered vertically, so that the storage air circulates around them to the ceiling.

Pans of sheet metal should have one-half to 1 inch of board-form insulation on the bottom, to prevent moisture condensing on the lower surface as it does on the ceiling. The pans should slope downward at least an inch per foot or follow the slope of the ceiling if it is greater (fig. 21).

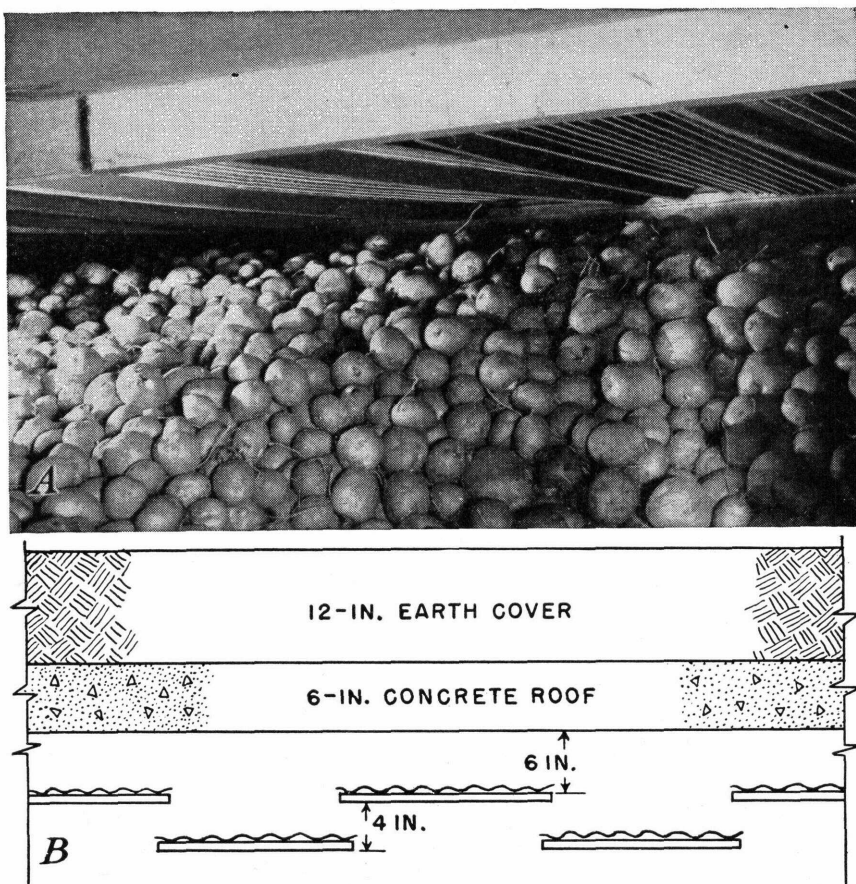


Figure 21. — A, Ceiling drip pans (or drains) in storage at Paw Paw, Mich., made of corrugated sheet metal with $\frac{1}{2}$ -inch board-form insulation on the bottom. Alternate pans are staggered vertically 4 inches to permit air to circulate around them from the top of the potatoes to the ceiling. These pans are 6 to 10 inches below the ceiling and follow its slope. They drain to gutters at the outside walls, and these drain to a sump in the storage floor. B, Cross section showing location of drip pans.

SINGLE-DRIVE ROOFED STORAGE

Single-drive roofed storages (see cover-page illustration) are laid out like the single-drive earth-covered ones, but are in many respects similar to the deep-bin storages. They have the same balance in the use of insulation, air circulation, ventilation, and moisture condensation. This type has one drive alley that serves bins 8 to 12 feet deep, a greater depth than is usually possible in the earth-covered storage, but not so deep as is possible in deep-bin storages (p. 19). Although the deeper bins have more capacity per square foot of floor space, potatoes sacked during grading can be conveniently stacked only eight high. Thus in bins of greater depth there is considerable crowding during the grading of the first bins. The Nebraska type (fig. 22) fits well in level irrigated areas, where there are few sites for bank stor-

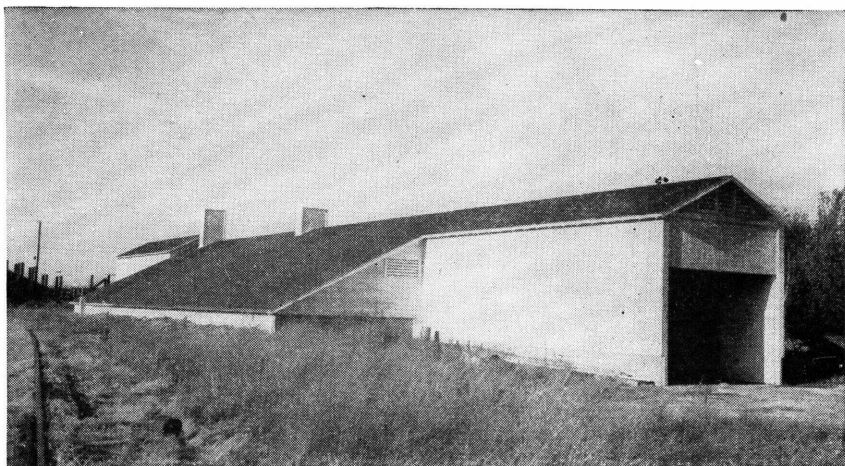


Figure 22. — Nebraska-type farm or trackside storage. Larger storages of this type have a drive-through alley with an entry at either end. Smaller ones (fig. 23) have but one entry. Louvers in ends and central roof ventilator are connected with the attic only. The higher end outtake ventilator is for the storage proper.

ages. The floor is 4 feet below grade and is reached by a 24-foot ramp down from grade level. Entries are often built over the ramps to exclude storm water and trash. The walls of the entry and those at the building ends may be utilized in constructing machinery or grain storage rooms at the sides of the entry.

DEEP BIN

Some newer type storages are partly above and partly below the ground, with work alleys at two levels. These storages have adequate provisions for handling potatoes and are designed to balance the use of insulation, air circulation, ventilation, and moisture condensation to obtain desirable conditions with little or no stove heat. Through reduction of handling injuries, potato shrinkage, and building depreciation the use of this storage type results in more marketable potatoes per dollar invested, though such storages may cost more to build than the old ones.

Deep-bin storage is better adapted to the late-crop potato areas, where average January temperatures are below 30° F., than to warmer areas. Its advantages are: (1) It retains the regulating effect of ground temperature in extremely cold weather, but can be quickly cooled in fall. (2) By the use of 4 to 8 inches of fill-type insulation, the above-ground part can be better insulated and waterproofed than would be practical with earth. (3) It is more practicable to get adequate working and ventilating room above the bins in this than in the other storage types.

Plans are available for deep-bin, gambrel-roofed storages ranging in capacity from 500 to 50,000 bushels. The carry-in storage (fig. 24) should be placed in a well-drained bank site. It has provisions for convenient ventilation and for filling and grading from storage. Exchange Plan No. 5618 (fig. 25) is also of the carry-in type, having a capacity of 2,000 to 3,000 bushels.

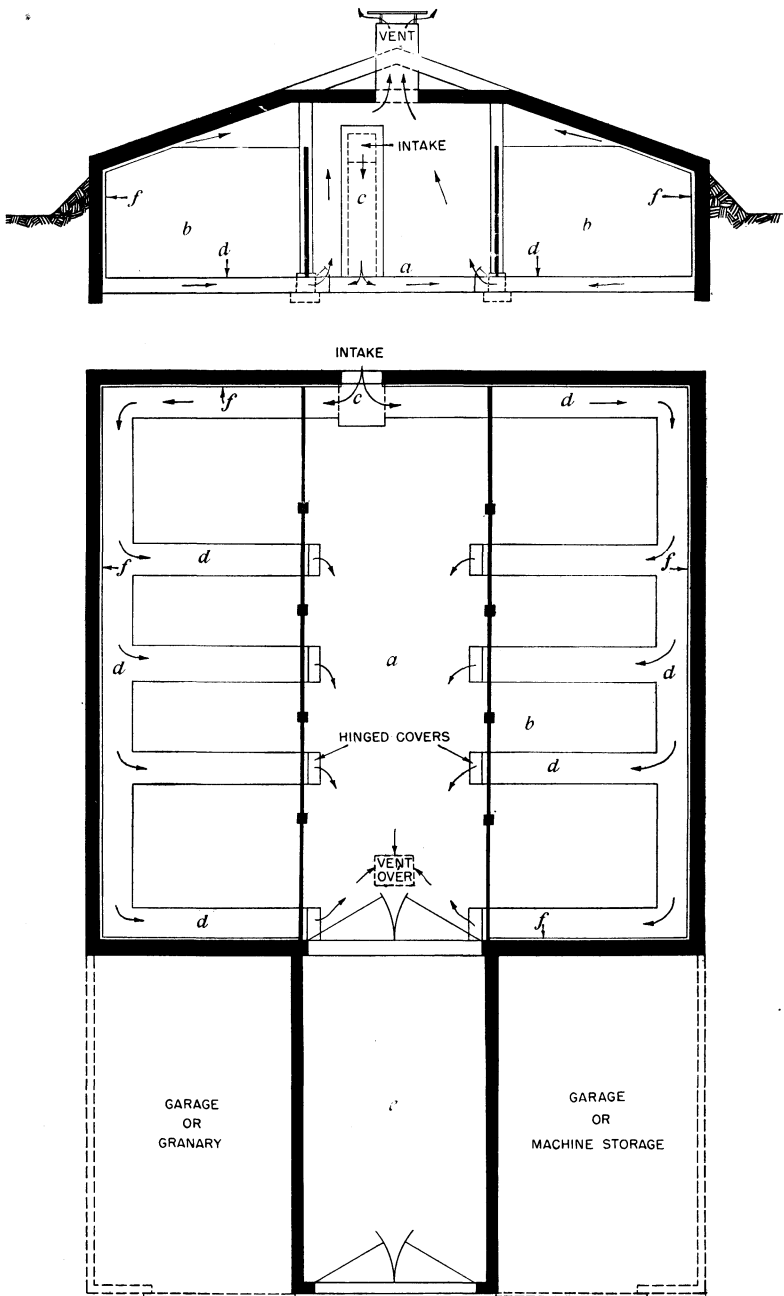


Figure 23.—Floor plan and cross section of Nebraska-type 6,700-bushel storage. Exchange Plan No. 5645. The entry ramp (e) and the work alley (a) are often concrete floored, but the bin floor (b) is usually of earth. The intake duct (c) may be controlled by automatic dampers (p. 32). It opens into rectangular floor flues (d) that carry both ventilating and circulating air from alley (a) to the wall air-circulation space (f).

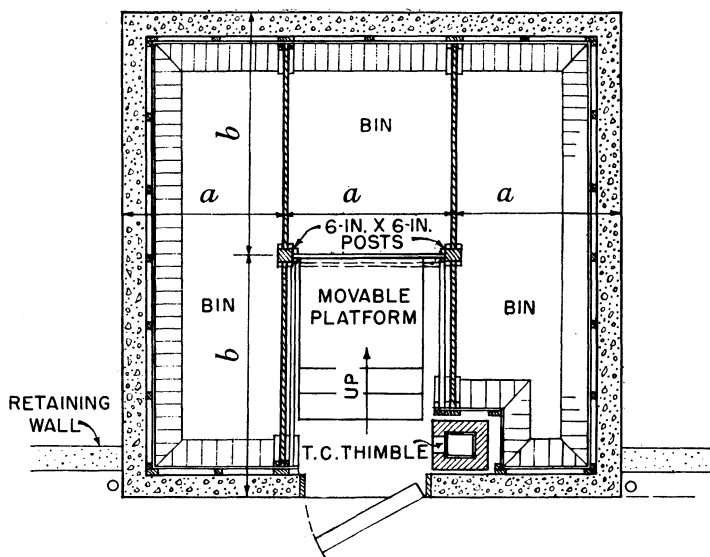
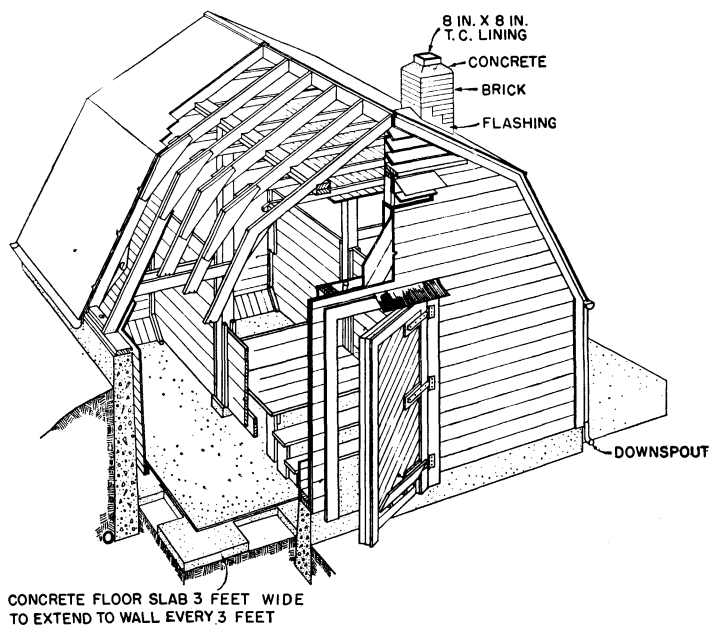


Figure 24. — Cutaway perspective and floor plan of carry-in 500- to 800-bushel farm potato storage. Exchange Plan No. 5617.

Deep-bin storages of 5,000-bushel capacity and larger are all of the drive-in type. They have drive alleys on the upper level and either work or drive alleys on the lower. The bins may be filled entirely from the upper alley or from both and are usually emptied from the lower level beginning at the end next to the lower door.

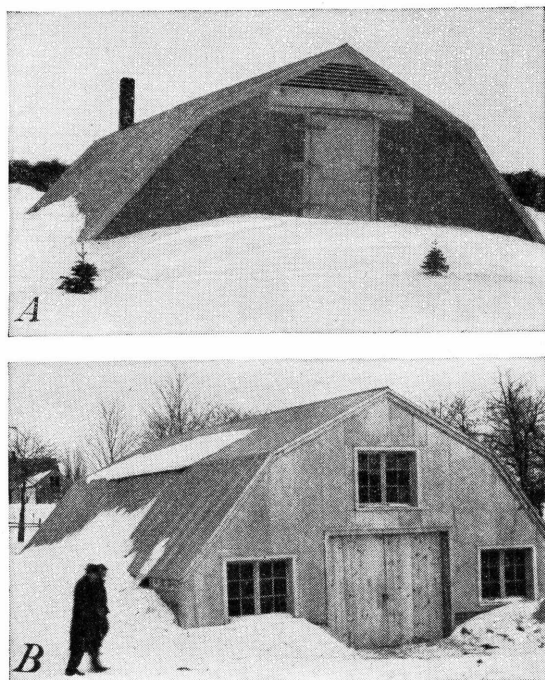


Figure 25.—Upper (A) and lower (B) entrance ends of carry-in 2,000- to 3,000-bushel farm storage. Exchange Plan No. 5618.

Bin fronts are usually made of loose 2-inch plank, 8 to 10 feet long, held in place by 2 by 2 cleats spiked to the posts that support the roof. Partitions are sometimes made in this way, permitting a flexible bin arrangement. The space at either side of the drive or work alley may be divided by cross partitions to form as many bins as are needed, and the alleys also may be used.

TRACKSIDE STORAGE

The North Dakota-type trackside storage (fig. 26) is similar to the deep-bin farm storages already described. The

drive-through upper alley is for filling and storage, the dead-end lower alley for grading, shipping, and storage. Because North Dakota temperature averages are so close to desirable storage temperatures, the extra deep underground part makes temperature regulation easy and artificial heating usually unnecessary. Potatoes graded in the lower alley are elevated to the railroad car by sack conveyors.

The Maine-type trackside storages (figs. 2, 5, and 27) are of the gable-roof type, having two separate storage floors that work out very well with barrel handling of potatoes between floors. Here the grading and shipping is done from the first floor. An electrically operated rope hoist, with an easily operated clamp for gripping the top of the barrel, is used for raising the barrels to the upper work space when filling the first floor in fall and from the cellar bins to the first floor when shipping. This barrel handling has made it practical to utilize 2-story storages and thus concentrate large quantities of potatoes along the railroad sidings. The 12-foot basement and 16-foot first-floor bins are a development from barrel-handling practices rather than from climate. Because a relatively large part of the storage is above grade, the use of stoves in winter is common.

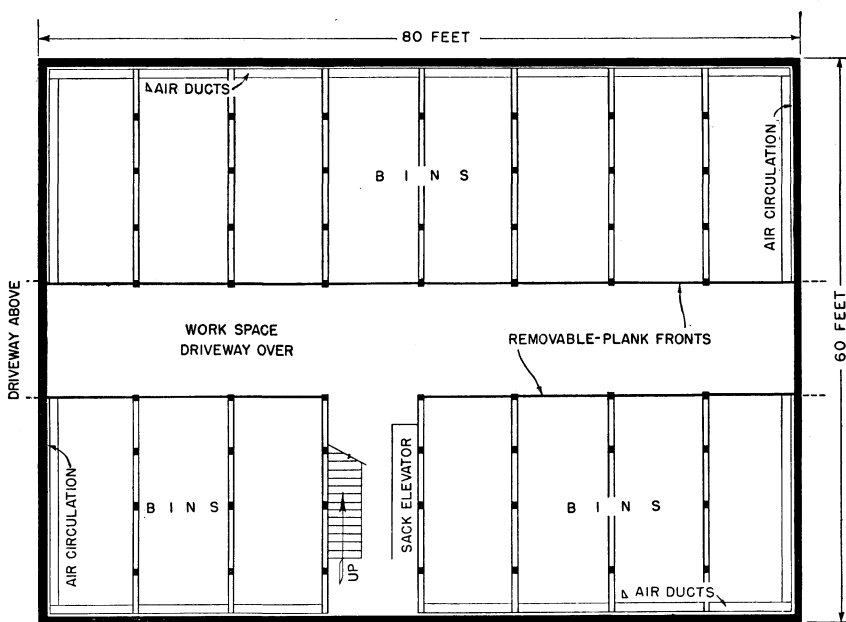
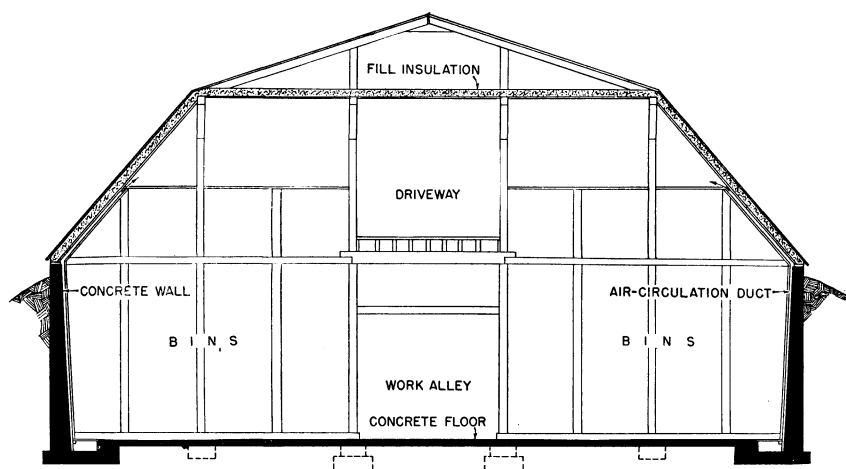


Figure 26. — Floor plan (below) and cross section (above) of North Dakota-type 50,000-bushel trackside storage. Exchange Plan No. 5646.

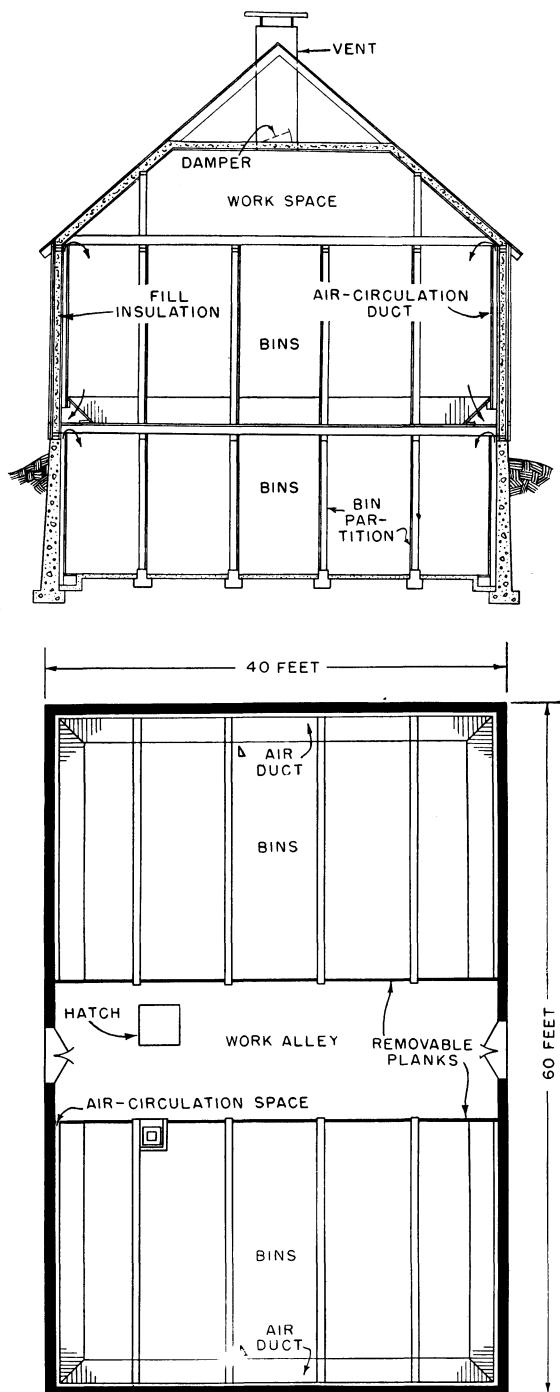


Figure 27. — Floor plan (below) and cross section (above) of Maine-type 32,000-bushel trackside storage. Exchange Plan No. 5647.

COMBINED STORAGE, WASHING, AND GRADING PLANTS

Most of the potatoes shipped from certain areas are washed and graded, since a premium market price justifies the extra expense. The washing and grading machines are relatively large,

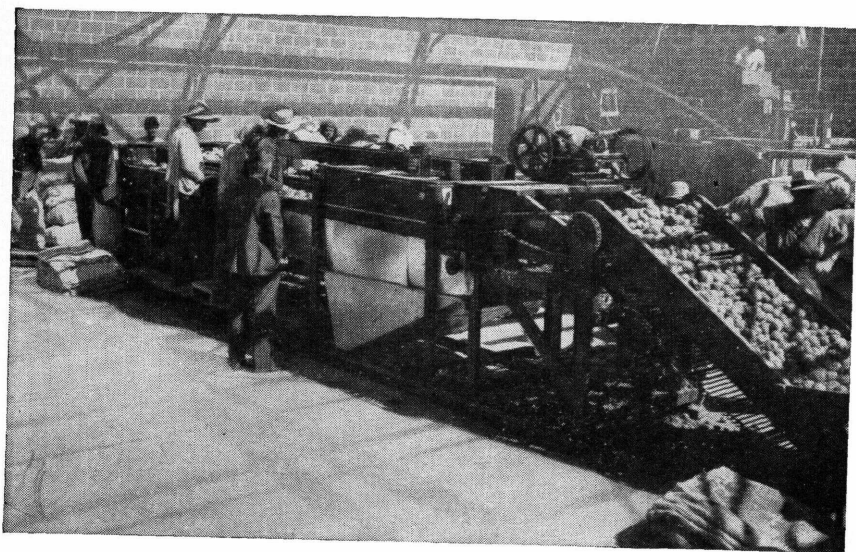


Figure 28. — Potato washing and grading. A crew of 30 may ship 6 to 8 cars a day.

employing about 30 workers per unit (fig. 28) instead of 6 or 7 per dry-grader unit. These plants may have the storage underneath the shipping space, as in figure 29, or at the end or side or in a separate building.

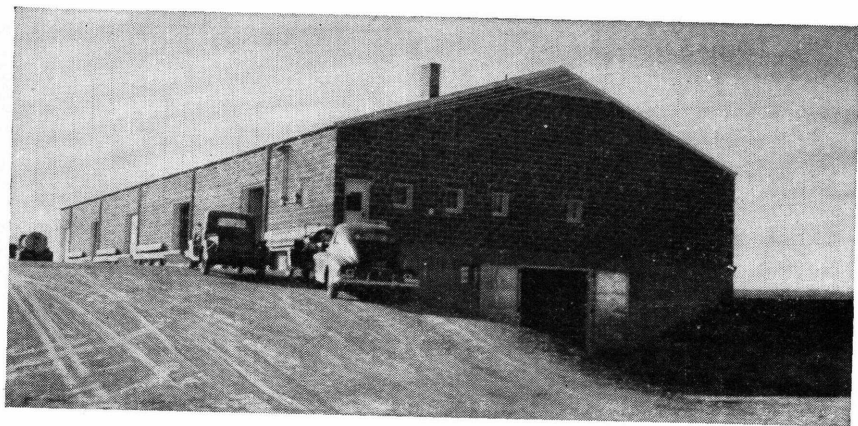


Figure 29. — Storage, washing, and shipping plant. These plants have storage capacities of 30 to 100 cars, but each may handle potatoes for other growers and ship about 1,000 carloads annually.

STORAGE CONSTRUCTION AND OPERATION

Storage construction and operation are here considered together, because the nature of insulation and the provisions for air circulation and ventilation are closely related to the regulation of storage conditions. The details of construction are shown in the blueprints of the exchange plans referred to in the text.

INSULATION

The thickness and kind of insulation in the exposed walls and ceiling of a storage determine the rate of heat loss through them at given inside and outside temperatures. Therefore, the rate of heat transfer through the walls or roof is about halved if the insulation thickness is doubled, and the more the insulation the higher the storage humidity can be before condensation takes place.

For many years storage walls and ceilings have been insulated by filling the space between the inside and outside sheathing with shavings or sawdust. Since such insulation was not protected from the moist air within the building, it absorbed moisture and lost its value. It also decayed and shortened the life of adjoining structural members, although to a certain extent it regulated humidity in the storage. Insulation was not altogether satisfactory until the practice of vaporproofing the wall between the insulation and the storage air was developed. This addition of a vapor-resistant lining between the insulation and storage maintains insulating efficiency and prolongs the life of the structure.

The insulating values⁶ of a few typical wall and roof constructions are shown in figure 30. Any of the masonry-wall types would also be satisfactory, if properly reinforced, for walls banked to within a foot or two of the top. If the gable ends or other storage walls that extend 2 to 10 feet above the banking are to be of masonry construction, either the double concrete wall, the double cinder tile, or other double masonry wall with fill insulation between walls should be considered.

The insulating values illustrate the greater resistances of frame construction as compared with masonry construction. For gable ends and roofs of the newer storage types, about 4 inches of sawdust, shavings, ground straw, or vermiculite are needed for areas having average January temperatures between 20° and 30° F. — that is, the insulating value of the wall and ceiling should be at least 10; about 6 inches are needed where the average January temperature is between 10° and 20° — that is, the insulating value should be about 15; and about 8 inches are needed where the average January temperature is between 0° and 10° — that is, the insulating value should be about 20.

Commercial insulations, which include all blanket-and-batt type and various mineral and vegetable fiber materials, have about 50

⁶ The insulating value is expressed as the number of degrees (F.) difference in temperature on the opposite sides of a wall that will cause 1 B. t. u. (British thermal unit) of heat to flow through an area of 1 square foot of wall in 1 hour. The greater the temperature difference, the greater the insulating value.

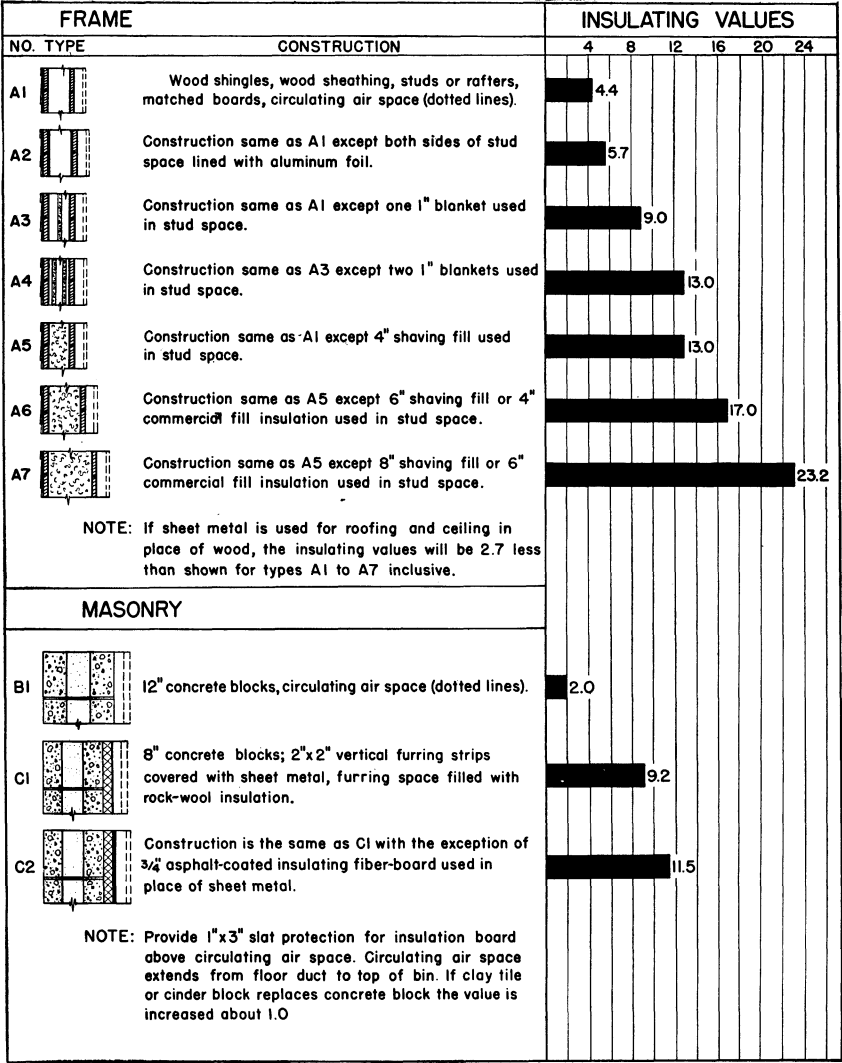


Figure 30. — Insulating values of some roof and wall constructions.

percent greater value than shavings and similar material. Therefore only two-thirds the thicknesses listed above are needed.

The inside lining of the insulated walls and ceilings should be made vapor-resistant by the use of (1) vapor-resistant paper⁷ protected by wood sheathing, (2) vapor-resistant insulation or

⁷ No practical storage lining is absolutely vaporproof, but some are more vapor-resistant than others. Heavily asphalt-saturated and -coated kraft paper, with both surfaces shiny, and light-weight roll roofing (not tarred felt) are excellent as vapor-resistant linings.

other vapor-resistant board with additional asphalt coating of the inside surface and sealing of the joints when in place, or (3) corrugated sheet metal with the joints lapped and made vapor-resistant with a plastic compound. Insulation should be installed so that any moisture penetrating the vapor barrier can escape to the outside air. This is done by making wall spaces connect with the attic and providing the attic with louvers or other openings to the outside air.

CONDENSATION

Condensation on the walls and ceiling of a storage is not objectionable unless it causes rot or rust or reduces the efficiency of the structural members and insulation or unless the condensed moisture drips on the potatoes. Moisture condensed on the inside surface of the exposed concrete wall during extremely cold spells may serve a useful purpose, for it will not harm the concrete wall but will temporarily reduce the humidity within the storage to a point where excessive moisture will not condense upon the better-insulated ceiling and drip on the potatoes below.

The humidity that may be held in a storage before condensation begins on the outside walls or ceilings is dependent upon inside-outside temperature difference and the insulating value of the different parts of the building.⁸

AIR CIRCULATION

Continuous air circulation is needed in a storage, even though it is not being ventilated by the introduction of outside air. The purpose of air circulation is to equalize the temperature in the different parts of the storage, thus preventing freezing near the walls or sprouting or spoilage by a too-high temperature at the bin center.

Customary operation of common (not refrigerated) storages tends to lower the humidity below the point desirable for potatoes during the period when it is necessary to ventilate for cooling. High relative humidity (85 to 95 percent) of air in contact with the potatoes is most desirable during the early part of storage to promote wound healing and during the rest of the season to reduce shrinkage. Particularly in that part of the country where average January temperatures are below 25° F. (fig. 4, p. 6) storages are usually kept tightly closed during cold weather. This raises the storage humidity to near saturation, which would be desirable for the potatoes if excessive ceiling condensation and dripping could be prevented.

No practicable degree of insulation, however, will prevent condensation at near-saturation humidity in the coldest weather. Ventilation should be used to reduce the humidity and condensation,

⁸ When it is 0° F. outside and 40° inside, moisture will condense on the inside surfaces of wall or ceiling as the storage relative humidity rises, in the following order: On a concrete wall with insulating value of 1.5, at an approximate humidity of 50 percent; on a wall with insulating value of 3, at 71 percent; of 6, at 85 percent; of 12, at 92 percent; and of 24, at 96 percent.

even if stove heat is required to keep the temperature from dropping. If storage bins have tight walls and floors with air circulating around instead of through the bin (fig. 31) or if potatoes are

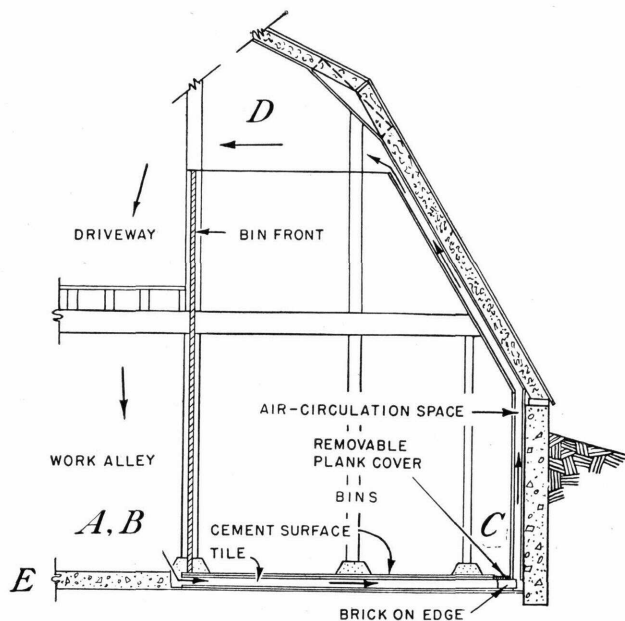
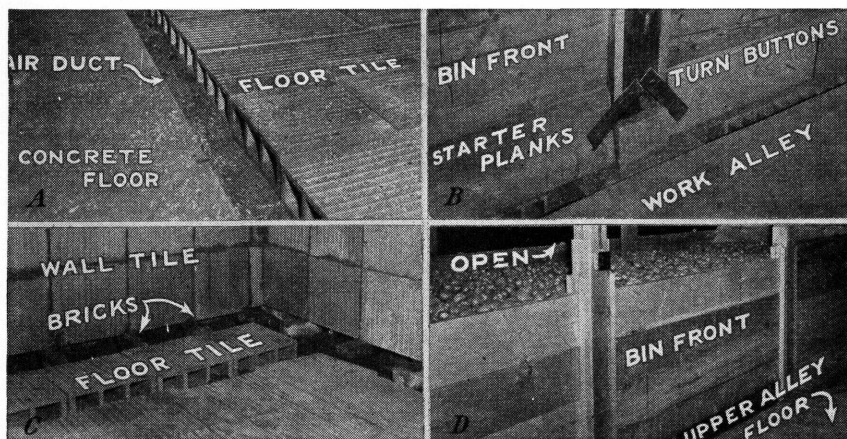


Figure 31.—Air circulation under the floor and in the walls (called shell circulation), by providing uniform temperature within bins with minimum air movement among potatoes, decreases shrinkage losses. A, Open-end floor tile at bin front before applying concrete topping. B, Tile covered with concrete and bin filled with potatoes, the tile opening into trough at the edge of work alley; bin fronts are tight, and starter planks at bottom are held in place by turn buttons. C, Tile extends up the concrete walls, with a clean-out space to be covered by a removable plank resting on bricks at the bottom; space between first two rows of tile permits air supply to flues formed by vertical tiles of partition at right. D, Above the tile, air-circulation space is formed by lumber nailed to 2- by 4-inch furring strips; view shows top of a 15-foot depth of potatoes that extends from the lower floor to above the upper drive floor. E, Diagram of gravity circulation; letters show where the photographs (for A to D) were taken.

stored in tight containers, high humidity will be maintained around the potatoes automatically, regardless of ventilation for cooling. In dry climates, if the storage bins are the slatted-wall type or the slatted-wall-and-floor type (1- by 4-inch slats spaced 1 inch apart), the work and drive alley should be kept sprinkled, and air for ventilation during the fall cooling period admitted through a spray or a sprinkled canvas or burlap curtain.

The storage plans listed in this bulletin provide for air-circulation spaces between the bins and the outside wall. Air-circulation spaces under the whole floor and connecting with the wall circulation space, as shown in figure 31, may be substituted for the triangular or rectangular flues shown in any of the other plans.

VENTILATION AND HEATING

Ventilation is the quickest means of changing both temperature and humidity within a storage during suitable outdoor weather conditions. It may vary from the smallest air seepage through cracks to forced ventilation. When first stored, potatoes give off large quantities of heat. Heat also comes from the earth through the storage floor and walls and from the outside air and sunshine during warm weather.

Where the average annual air temperature is below about 55° F. (fig. 3), fair to excellent long-period storage can be obtained without artificial cooling, but in warmer areas, storage for more than 3 or 4 months is difficult without refrigeration. In very cold weather or in poorly insulated storages in moderate weather the use of stove heat may be necessary (p. 13). Heating during grading may be done by forcing warm air into floor flues or by using fans to force it over the top of the inclined pile of potatoes as they roll down in the open bin.

All ventilation for cooling tends to lower the storage humidity, but high humidity (85 to 95 percent) of the air in contact with stored potatoes is desirable to promote wound healing and to reduce shrinkage. Outside the bin, however, the humidity should be low, to prevent ceiling condensation and dripping; so satisfactory cooling by ventilation is best accomplished in bins with shell circulation (fig. 31, p. 29), in which case ventilation does not materially lower the bin humidity. In fall, when it is desirable to cool without excessive drying, night ventilation is best. In winter, when condensed moisture should be removed with a minimum of cooling, day ventilation is best.

Good wound-healing conditions, 60° F. and 85 to 95 percent humidity, may be maintained without difficulty by closing doors and ventilators as soon as the storage has been filled. When several weeks are required to fill large storages it may be necessary to lower the temperature before the house is completely filled, to prevent too-early sprouting of the first potatoes stored by holding them too long at the high temperature.

Potato temperature usually drops from 60° to 50° F. after the wound-healing period without much attention, but to lower it to the required 40° for potatoes that are to be stored for more than 3 or 4 months particular attention must be given to ventilation,

especially in areas where the outside temperature averages above 40° in fall. Effective cooling by ventilation is possible in fall during an average of 8 hours a day. Early fall temperatures for an area are about the same as the average annual temperatures (fig. 3, p. 5).

Storage management may aim to keep potatoes in the best condition for more than one market. Part of the crop may be earmarked for selling as table stock between harvest and December 31; this lot will be in best condition if cooled to a minimum of 50° F. by the end of its storage period. Another lot may be selected for marketing as table or seed stock between January and June; to prevent sprouting, it should be cooled to 40° within 3 or 4 months of the end of the wound-healing period (see p. 3) and held at this temperature until the warm-up period just before marketing. To meet the requirements for both early winter table stock and late winter table stock or seed, a two-room storage may be desirable (fig. 32).

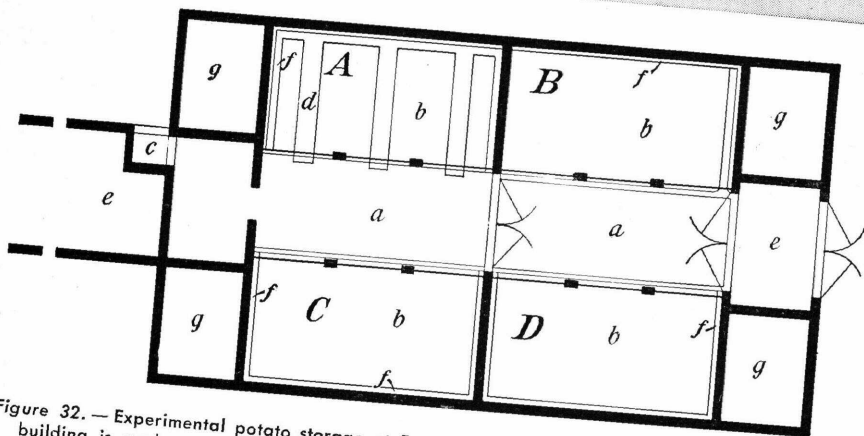
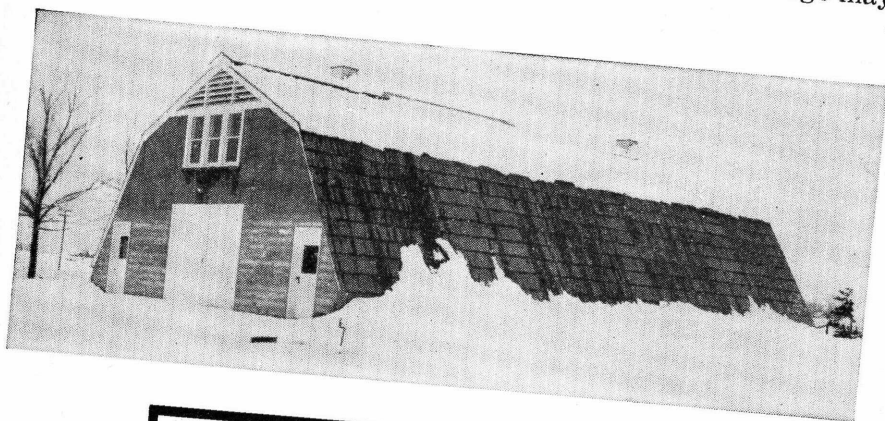


Figure 32. — Experimental potato storage at Fort Collins, Colo., and plan. This 38- by 70-foot building is made up of two storage rooms (AC and BD), four work and equipment rooms (g), and two ramps (e), up at left and down at right. The upper driveway is 11 feet above the bin floor. The storage rooms are divided into deep bins: A with earth floor (b), having rectangular floor flues (d) to convey air from work alley (a) to wall air-circulation space (f); B and C with tile wall and floor air-circulation spaces (fig. 31); and D with wood floor and wall air-circulation spaces (f). Intake grating to thermostatically controlled damper (fig. 33) is at c.

Ventilation may be either "gravity" or "forced." About a cubic foot of air per minute is needed for each 160 pounds of stored potatoes. In a gravity system outside air enters the storage near the floor through an intake or door close to the stove. (In extremely cold weather the cold air should be warmed before it circulates through the storage.) The air should be introduced

at one end in relatively short buildings and at the middle in long ones. An outtake ventilator should be placed in the ceiling of the end opposite the intake ventilator in short storages and at either end in long ones. Ventilator sizes are shown on the working drawings for each of the storages illustrated.

Intake ventilators may be either manually controlled or motor-operated and thermostatically controlled. Automatic regulation has an advantage over manual control in that it starts ventilation as soon as it is cold enough for cooling and stops it when it is either too warm outside or too cold inside. The operation of a thermostatically controlled motor-operated damper in a storage with gravity ventilating system is shown in figure 33.

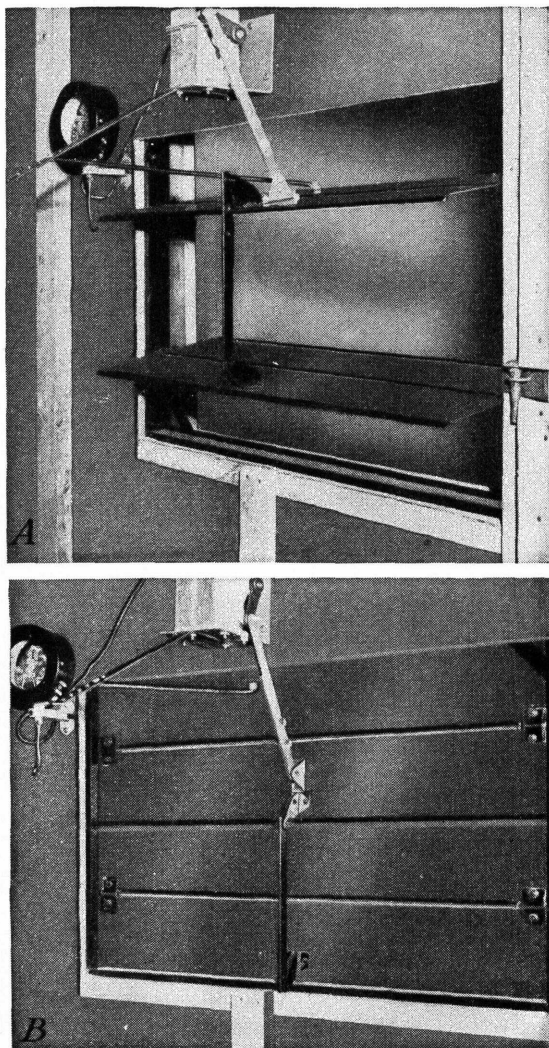


Figure 33. — Thermostatically controlled motor-operated damper used as intake in a storage with gravity ventilation. The outtake ventilator is at the roof. A, Damper opened. The motor (top center) is wired in series with maximum thermostat (left) and minimum thermostat (below, not shown). The motor is stalled although the current is still on, and it will hold the damper open as long as the outside temperature is below the set maximum and the inside temperature is above the set minimum. B, Damper closed. The motor current is off, and a spring holds the vanes closed. Damper will remain closed as long as the circuit is broken, because it is too cold inside or too warm outside.

Thermostatically regulated intake dampers used with gravity outtake ventilators should have cross-sectional areas equal to those of the corresponding outtake ventilators.

In forced ventilation the arrangement of intake and outtake openings is the same as that for gravity ventilation, but the intake damper is replaced by a fan or blower (fig. 34), and the outtake damper at the roof can be smaller. Suggested fan sizes and corresponding outtake damper dimensions for various storage capacities are shown in table 1. When ordering a fan, specify that it is to work against a maximum static pressure of one-quarter inch of water.

Although a forced ventilation system can be manually controlled, thermostatic regulation is more satisfactory where the expense is justified. The sectional view in figure 15, page 13, shows a system in which the blower runs continually, and the inlet damper is thermostatically controlled to switch from ventilation with outside air to recirculation of inside air as required to maintain the specified constant temperatures in all parts of the house. Under this system, the outtake dampers should close automatically when the change is made from outside to inside air.

With thermostatic control of either damper or fan motors, two thermostats are required: (1) A minimum thermostat placed low in the storage so as to be in the air draft of intake and set at the coldest temperature wanted (usually 32° to 36° F.); (2) a maximum thermostat placed outside the storage in a shaded position, or its bulb in the out-

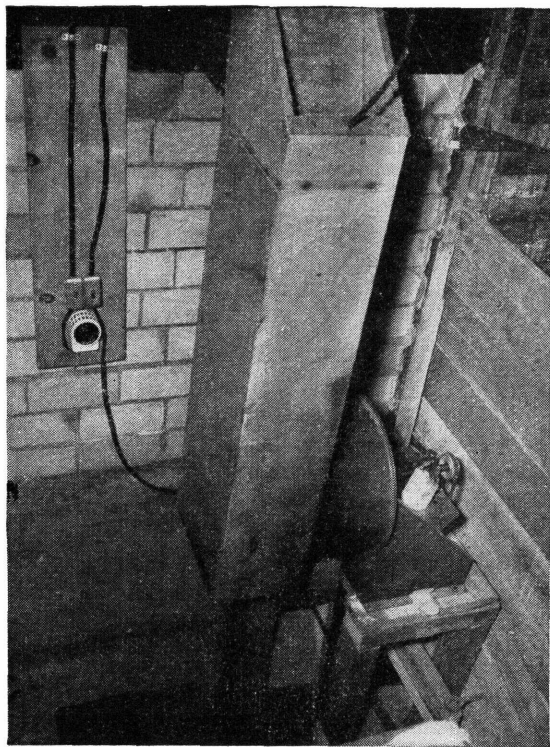


Figure 34. — Thermostatically controlled motor-operated blower, for forced air circulation and ventilation. Minimum thermostat (left) closes circuit to run fan whenever the storage is above the set minimum, but differential thermostat (not shown) may break circuit whenever it is warmer outside than inside. Both circuits must be closed to run fan; either may break and stop fan. In operation, air is drawn into fan chamber from outside (top left) or from upper part of room, according to set of damper (top center). Fan may discharge the air into floor circulation system (similar to that in fig. 31) or into work alley, according to set of the damper (bottom center). Blower is also wired for manual operation, independent of the thermostats; this circuit is used for forced circulation within the storage.

TABLE 1. — *Ventilating fan sizes and approximate dimensions of corresponding outtake dampers for various storage capacities*

Storage capacity	Fan sizes	Inside dimensions of outtake dampers	Storage capacity	Fan sizes	Inside dimensions of outtake dampers
<i>Bushels</i>	<i>Cubic feet per minute</i>	<i>Inches</i>	<i>Bushels</i>	<i>Cubic feet per minute</i>	<i>Inches</i>
500.....	190	6 x 6	6,000.....	2,250	18 x 18
1,000.....	375	8 x 8	8,000.....	3,000	21 x 21
1,500.....	560	9 x 9	10,000.....	3,750	24 x 24
2,000.....	750	11 x 11	12,000.....	4,500	26 x 26
3,000.....	1,125	13 x 13	16,000.....	6,000	30 x 30
4,000.....	1,500	15 x 15	20,000.....	7,500	34 x 34

side shade, and set at the maximum temperature wanted (usually 40° to 45°). These thermostats are wired in series with the damper or fan motor. In operation the minimum thermostat breaks the circuit (stops the motor) when its minimum set temperature is reached, and the maximum thermostat breaks the circuit (stops the motor) when the outside air is above the set maximum. The outside air must be below the set maximum and the inside air above the set minimum to have both thermostats complete the circuit and run the motor.⁹

Gravity ventilation requires less equipment but more attention from the operator than forced ventilation. When electricity is available, forced circulation and ventilation is recommended if close temperature regulation is desired, especially if the storage is located at some distance from the farmstead.

BIN DIMENSIONS

Bin dimension for bulk potato storage should be based on the means of regulating temperatures, the handling provisions, the quantity of potatoes in different lots, and the necessity for supporting the roof or floor above by rows of posts.

Large bins are more difficult to maintain within a narrow temperature range than small ones, so the warmer the climate or the longer into spring the potatoes are to be stored the smaller the bins should be. Large bins, however, may be divided by partitions. With adequate provision for floor and outside-wall circulation, bin width and length do not greatly affect temperature regulation. Bin depth should be limited to 4 to 8 feet in areas of average annual temperatures above 55° F. (fig. 3), while in colder regions the depth may be 12 to 26 feet. In warmer areas, where floor circulation is not provided, bins should be 6 to 10 feet wide, with double-boarded partitions for air circulation. In colder areas single-boarded partitions are sufficient.

⁹ A differential thermostat may be used in place of the maximum thermostat in the same wiring arrangement. It has an inside and an outside temperature bulb and is set to break the circuit (stop the motor) whenever it is warmer outside than in.

Where potatoes are carried into bins, handling difficulties limit the depth to 10 or 12 feet above the alley floor and the length to about 30 feet back from the alley. If conveyors or hoists are used to take potatoes or containers of potatoes from the truck, greater bin depths and lengths are practical. When the drive alley is above the bin floor, depths of 12 to 26 feet may be used to advantage.

The quantities of potatoes to be kept in separate lots and the need for rows of posts to support the roof or upper floor are the usual reasons for dividing bins by partitions 6, 8, 10, or 12 feet apart. This is particularly true where cold-climate and floor-circulation provisions make it unnecessary to cool bins through circulation in double-slatted or boarded partitions.

SAFETY

No structure is sound that does not provide safe working space. Structural members should be strong enough to prevent failure. Workmen should have adequate headroom and be required to do a minimum of climbing on ladders and over braces in carrying on the usual activities. Where electricity is available the storage should be wired to provide lights and current for grading and conveying potatoes and operating fans.

In general the outlets and lights should be placed where they are not likely to be struck by trucks, grader, or other movable equipment. Molded-rubber receptacles without switches are preferred because they are moisture-resistant and not easily damaged. Switches near main entrances are all that are needed. Flexible, non-metallic conduits placed according to wiring codes are preferred because of economy and resistance to moisture. Experience has indicated that unless metal conduits are filled with a hot molten compound like "pothead compound" before being placed in service, condensation will eventually result in shorting between wires.

To facilitate the use of stove heat in cold weather, most storages should be equipped with a fire-safe chimney and a concrete stove platform.

ESTIMATES OF COST

The cost of storage construction will vary so much from year to year, from place to place, and according to choice of materials and to variations of skill of labor and management, that a cost estimate made at one time and place on the basis of a given set of materials and the work of one contractor has no place in a general bulletin. A basis for estimating construction costs is given, however, in the following paragraphs.

MASONRY

If a storage is built at a site where sand and gravel are readily available and soil conditions are favorable for construction, the cost of concrete work will be low. The walls used in some of the storages illustrated in this bulletin are relatively low and require little or no reinforcing. The ones illustrated in figures 26 and 27, pages 23 and 24, however, do require the reinforcing detailed on

the plans. The labor and the ingredients for masonry work are indicated in table 2. These figures are based on the use of a one-sack mixer and farm equipment.

LUMBER

On the basis of time and nails usually required per thousand feet of building material, an estimate of lumber construction can be made if the local costs of lumber, labor, and nails are known. Usual erection time and nail requirements for various items of construction are given in table 3.

INSULATION AND VAPORPROOFING

Insulation used to fill the spaces between studs, rafters, and ceiling joists may be either blanket or batt type or the granular-fill type. This insulation must be installed with vapor-resistant liners between it and the storage air. The labor required for applying 1,000 square feet of insulating material will range from 6 to 12 hours and that for vaporproofing from 4 to 6 hours.

MISCELLANEOUS ITEMS

The additional materials of construction include hardware, sheet-metal work, painting, electric wiring, and sometimes plumbing and water supply. Although there appears to be no satisfactory method of estimating all these items, owing to variation between buildings, labor for some of them is indicated in table 4.

TABLE 2. — *Materials and labor required to build 100 cubic feet of 12-inch masonry wall¹*

Type of masonry	Masonry		Mortar	Mortar and concrete materials				Labor	
	Size	Quantity		Cement	Hydrated lime	Sand	Gravel	Skilled	Unskilled
Concrete forms	Inches	400 board feet	Cubic feet	Sacks	Pounds	Cubic yards	Cubic yards	Hours	Hours
Poured concrete	1:2¾:4 mix ²	4 cubic yards		20.0		2.6	3.0	15.0 2 6.5	5.0 2 19.0
Concrete block	7½ x 15½ x 11½	115 blocks	5.2	1.5	14	.20		3 3.0	3 9.0
Clay tile	11½ x 11½ x 11½	105 tiles	6.65	1.9	18	.25		4.5	4.0
Brick	2¼ x 3½ x 7½	2,100 bricks	32.4	9.2	87	1.20		7.0	6.5
								18.0	22.0

¹25 percent waste is figured for the mortar used in the masonry units, ¾-inch joints for the concrete blocks, and ½-inch joints for tile and brick.

²Hand-mixed.

³Machine-mixed. Farmers' Bulletin 1772, Use of Concrete on the Farm, has detailed information on mixes.

TABLE 3. — *Labor and nails required per thousand board feet of lumber construction*

Items of construction	Labor	Nails	
		Weight	Size
	<i>Hours</i>	<i>Pounds</i>	<i>Penny</i>
Framing.....	20	25	20
Shiplap and sheathing.....	13	40	8
Siding.....	19	30	8
Shingles ¹	4	4	3
Trim ²	1 1/2	1/2	6

¹Per 100 square feet. ²Per each side of wall opening.

TABLE 4. — *Labor requirements for miscellaneous materials in storage construction*

Items of construction	Unit	Labor per unit
		<i>Hours</i>
Anchor bolts and dowels.....	10 (number).....	1.0
Reinforcing rod.....	100 pounds.....	1.5
Hardware for large insulated door.....	Each.....	8.0
Flashing, troughs, and downspouts (4 and 6 inches).....	100 linear feet.....	10.0
Painting (cover 300 square feet per gallon).....	1 gallon.....	3.4
Wiring, nonmetallic sheathed cable:		
Lighting outlet.....	Each.....	1.25
Power outlet.....	Each.....	4.0
Electric service entrance (3 phase, 4 wire).....	Each.....	12.0

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